Microbial Containment

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**Introduction**

We’ve all seen the commercials, guaranteeing they are the right agent for the job:

“For a healthier house and a happier home,” says Clorox.

“Start Healthing,” urges Lysol.

“We work hard, so you don’t have to,” claims Scrubbing Bubbles.

But, which cleaning product is the winner? All three product manufacturers state that their products kill 99.9% of germs. It seems fairly safe to assume that any one of these products will effectively clean whatever mess you are tackling. You can further manage microbes through other products that claim to kill 99.9% of germs, like hand soaps and air fresheners. But, how well do they really work? Why can’t they get that pesky .01% of remaining bacteria? Is that .01% even something to be concerned about? Have you stopped to think about these questions? Before those questions can be answered, it is best that you have an understanding of what a microbe is and the ways that you can control them. Let’s go over the basics of these organisms that we are trying to regulate.

**What is a Microbe?**

As defined by the National Institute of Health, a microbe is an organism so small that it can only be seen under a microscope. These organisms continuously surround us; they are also found on and inside of many members of the animal kingdom. They can be found in the air, water, soil, and vegetation. They colonize our skin, hair, gastrointestinal tract, mouth and more. You can come in contact with them when you touch objects such as a countertop, door handle, mobile phone, kitchen sink, toys, etc (Hitti, 2007). You can exchange bacteria when you shake someone’s hand, share a drink or use a public computer. While many of those organisms we encounter daily are harmless, some of those microbes are harmful. Tapeworms are organisms that can intrude the human digestive system and live within the stomach, causing various types of harm, including the possibility of death, to the host (Craig, 2007). This organism is considered a **parasite** and displays a **parasitism relationship**, which is an association wherethe organism harms the host. As mentioned previously, others microbes are not harmful like *Demodex folliculorum*. *D. Folliculorm* are microscopic mites that live in our hair follicles (Bikowski and Rosso, 2009). These mites do not pose any threat to humans yet use our hair follicles as hiding places from potential predators. This type of association is considered a **communalistic relationship**, where the host is not harmed but it does not benefit. Some microbes are essential for the survival of living things. Research has shown that mycorrhiza fungi allows the host plant to receive more nutrients in the form of carbohydrates, which allows the plant to grow better (Kirk, 2001). This fungi/plant relationship is an example of a **mutualist relationship**, where both the host and the organism benefit from the association (Kirk, 2001). In terms of microbe control, we are concerned with microbe organisms that can cause disease, **pathogenic microbes**. Pathogenic microbes always create a parasitic relationship between its host. There are four main groups of pathogens, which are: Protozoa, Fungi, Bacteria and Viruses. The most common of pathogenic microbes are bacteria and viruses, which are the two microbes our household cleaning products, mentioned earlier, are targeting. **Bacteria** are single-celled prokaryotic organisms (Murray, 2013), while **viruses** are small, infectious particles that must attach to a host in order to reproduce and survive (Murray, 2013). **Prokaryotic** organisms are one that do not contain any bodies, such as a Golgi apparatus, mitochondria or even a nucleus. Viruses are much smaller than bacteria and other prokaryotic organisms, almost by 100 times. Their structure is simple in that they only contain nucleic acid, a capsid and sometimes an envelope. But, how is that we can fight off these two different pathogenic organisms?

**Microbe Control**

Control over the harmful microbes is done through the four main methods. Those four control mechanisms used to regulate bacteria are the following: disinfection, sterilization, antiseptic application and vaccinations. When those four techniques are not effective, then the last line of control for microbes is antibiotic treatment. Let’s take an individual look of those mechanisms.

Disinfection uses a **disinfectant**, a chemical substance that is specifically designed to kill harmful germs and bacteria (Merriam-Webster, 2015). **Disinfection** eliminates a certain range of microbes with a disinfectant but it cannot kill resilient forms. Aerosols, alcohol, bleach, chlorine, hydrogen peroxide and **phenolics** (the active ingredients in common household cleaners) are the most frequently used forms of disinfectants. These chemical ingredients are applied or sprayed onto a contaminated surface which then triggers a chemical reaction to occur between the disinfectant and the microbe. For example, the laundry detergent Tide with oxi clean uses a phenolic to attack the pathogens cell membrane enzymes cause the pathogen to become dehydrates and die. **Sterilization** is the process that eliminates and destroys all forms of microbes, including the resilient forms of spores and prions (Merriam-Webster, 2015). Heat, chemicals, filtration, irradiation and pressure are key components of sterilization. Sometimes sterilization will be a combination of two or more of those components- this is typically done to destroy **prions**, the most resistant bacterial form. A common sterilization method is steam sterilization with an autoclave. Tools and equipment, especially ones used in a medical setting, are placed into an autoclave where hot steam and water create too much pressure for organisms to survive. **Antiseptics** are substances applied to the skin to reduce the number of bacteria present and to inhibit growth of the bacteria (McDonnell, 1999). Iodine, typically found in any first aid kit, is applied to the skin before surgery or is gently rubbed on minor wounds to cleanse it. Iodine is the most well-known antiseptic.

Most commercials for household cleaners show a person spraying an area and wiping the agent off within seconds. Microbial management isn’t as simple as the commercials portray. There are many factors that determine if those chemicals will be effective. When wishing to eliminate microbes one must think of many factors, such as environmental influences, type of bacteria are you trying to eliminate, if the bacteria is resistant to any of the active ingredients of the cleaner you chose (Murray, 2013). You should also be wondering how long the cleaning agent should be applied and in what concentration (Murray, 2013).

Some environmental questions you should be asking yourself before use of a cleaning agent are things like: Is the surface in which you are applying a bacterial killing chemical on hot or cold? Is the surface you are spraying metal, wood, plastic or something else? How long should the chemical be applied before removing? What is the pH level of the water in your high school swim team’s pool?

Questions about the actual organisms should be the following: What type of microbe am I trying to defeat? Is it a less resistant form like bacteria, a mildly-resistant form like viruses or the most resilient form of spores and prions? Are you using the correct chemical agent and/or method/s for the type of ‘germ’ present? Can the organism you’re trying to kill become resistant to the cleaner you are using or plan on using? Does it have any virulence factors to help resist being destroyed? Is it capable of completing **bacterial conjunction**? In other words, can the bacteria transfers its genetic make-up to another bacterium and spread?

Questions about the cleaner should include: What is the concentration of the cleaner being used? What is the concentration of microbes present? Is enough cleaning product applied to be effective?

Once you had determined the environmental factors, such as a granite countertop and you have identified the type of bacteria most likely to be present, such as *Escherichia coli* from cooking raw meat for dinner, then you are able to decipher what type of cleaning agent to use. In this example, the bacteria are located on an outside source, not skin and we are not able to place the countertop into an autoclave, therefore, spraying a disinfectant would be the best method of destruction.

**Microbial Control Actions In-Depth**

To even further answer our questions about microbial control methods, we must have a basic understanding of how the active chemicals in our household cleaners work. A sequence of events takes place to finalize the destruction of the microbe. The first action is allowing a chemical agent to come in contact with the cell surface of the microbe. The second action is the cleaning agent penetrating the organisms cell wall allowing the final action to take place inside the cell, which is typically inhibition of the cell or cell death. In the last phase, a number of actions can take place in order to eliminate the entity. The chemical agent can mix its own proteins with the microbe’s proteins, causing the cellular structure of those microbes to change (Murray, 2013). The restructured organism is now harmless and completely inactivated without its original protein content. The chemical agent could also cause damage to the microbe’s membranes in the cell wall. When an organism’s cell wall is damaged it is no longer able to survive. The cleaning application could cause leakage of the bacterial or viral cell contents. A pathogen will die if cellular structures, like **amino acids** leak out. Amino acids encode for a cellular figure’s genetic make-up, they are the building blocks in which a cell survives and replicates (Murray, 2013). If a microbe cannot replicate then it has been inhibited, which can be another microbe killing action caused by the chemical agent applied.

Let’s apply this to our household cleaning agents. Imagine your mother, spending countless hours cleaning your home before your brother’s 10th birthday party. Your brother was sick a week prior and your mother wants to ensure that she has killed any germs that may be present from your brother’s illness. Your mom appears to have done everything right. She took your brother to the doctor when she noticed he was ill and not finding relief. The doctor confirmed, through biochemical testing, that your brother was suffering from Strep throat caused specifically by *Streptococcus pyogenes* (Vincent, 2004). Your mother made sure that your brother took all of his medication prescribed, never missing a dose and not leaving any amount behind. Now, she is cleaning the aftermath of what is most likely contaminated. Your mom did her research and knew that she needed to be using a cleaner with the active ingredient sodium chlorite, as *S. pyogenes* is susceptible to the chemical (Collins, 1983). But, your mother was running low on the disinfectant wipes, containing sodium chlorite, and used them sparingly. The wipe company claimed when used, that they would kill 99.9% of germs. Your mother trusted this cleaning agent. But, what she did not know was that the concentration of the active ingredient, sodium hypochlorite, was relatively low compared to the amount of Streptococcusbacteria currently residing in the home. The lack of concentration needed to destroy the bacteria caused your brother’s friends to become ill within days of his birthday party. This is an example of how that .01% of bacteria can still remain active and alive after one has disinfected the area. Other ways that cleaning agents are blocked from removing all organisms are by using the incorrect method or improperly using the agent. If a doctor uses hydrogen peroxide during surgery, rather than iodine, the surgeon risks hydrogen peroxide breaking down into water and oxygen which could cause gas inside the surgical site. You can misuse the product by not allowing it adequate time to inhibit or destroy the microbes it comes in contact with or by spraying the agent but never removing it from the surface- which means you never removed the organisms either.

**What about prevention?**

There are two main preventative methods that you can take to ensure you are eliminating bacteria and pathogens: cleaning and vaccinations. Cleaning can be applied to objects found in the home or yourself. Ensuring that you have properly washed a used dinner plate, by removing all food particles, allowing it to dry and even sanitizing it in a dishwasher can help avoid microbe growth and furthering spreading. The University of Rochester’s Medical Center claims that washing your hands frequently after certain occasions, like using the bathroom, playing with pets or changing diapers can also ensure that microbes are not continuing to grow or spread. But, to prevent well-known pathogens, we rely on vaccines. **Vaccinations** are typically injections of live or denatured particles of a pathogenic microbe. The injection of the harmful organism activates our immune responses in order to defeat the harmful effects of the microbial suspect. If you have received a vaccination, like the Varicella vaccination, you will not become ill with the chicken pox when you come in contact with the Varicella Zoster virus. Essentially, this preventative method has already taught your body how to attack and destroy the virus. Vaccines, like the Varicella vaccine, allow your body to control what microbes will not harm your body. They may even control what microbes will not affect your neighbor, friend of sibling. Vaccinations can help people who have not been vaccinated themselves. In a theory called herd immunity, if 70% of the population has been vaccinated, then those 70% of immune persons will fight off the infectious agent for the other 30% who has not been vaccinated (Murray, 2013).

**Last Line of Defense**

Remember the part of the story where your mother made sure that your brother took all of his medicine to cure his illness before his birthday party? Well, that medicine was specifically an antibiotic, which are the last line of defense for controlling bacterialmicrobes. Once a person has been infected with a pathogenic microbe and show signs of a pathogenic disease, doctors will try to control and destroy that pathogen through strict antibiotic regimes. There are over 100 antibiotics available for medical use that must be taken with specific instructions in order to be effective (Berger, 2014). Some of those instructions include taking the antibiotics with or without food and/or water, not combining the antibiotics with other medications, and taking the antimicrobial agent for a calculated amount of time. Completion of the antibiotic regime is essential in order to avoid resistance from the bacteria present. There are several classes of antibiotics but the weakest antibiotic will be given before the strongest in order to prevent bacterial resistance too. This control method should always be the last method used, as it is a reactive microbial control method and not a preventive or direct method.

**Conclusion**

To effectively control harmful organisms, you need to identify what type of microbes you are trying to eliminate, their location and concentration in order to be able to identify which method of control will be the most effective. Lastly, we must ensure that we are correctly completing the control methods without error. If these steps are taken, then we will be more effective in eliminating any pathogenic microbe we encounter. Otherwise, 99.9% of bacterial killing will not be achieved and bacteria could replicate, allowing them to become more resistant to our treatments. Let’s aim for that 99.9%!

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